Non-Destructive Testing Methods for Detecting Red Plague Within an Insulated Silver Plated Copper Conductor

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Description:
Red Plague is a galvanic corrosion of silver coated copper materials which occurs when the silver coating does not adequately cover the underlying copper and is exposed to water by either direct contact or condensation. Red Plague causes degradation of the anodic copper while leaving the cathodic silver plating intact. More details for causes and current mitigation provided in in SAE-ARP-6400, the NASA Red Plague Control Plan, and the European Space Agency’s “Corrosion of Silver-Plated Copper Conductor.” Therefore, the silver “straw” can carry current during a normal incoming inspection conductivity test and most system level high-frequency checks, but without the copper's strength and ductility, silver cannot carry the shock and vibration load in flight environments. Silver plated copper wire provides many advantages over other conductor systems such as excellent solderability, crimpability, and flexibility. The intent of this topic is ultimately to create a system which can be used to perform non-destructive testing on XL-ETFE insulated silver plated copper wire and determine acceptability prior to implementation within hardware. One proposed method for creating this system is by utilizing the skin effect. As frequency of a signal increases, a given conductor will carry more and more of the signal on the "skin" of the conductor. This is often referred to as "skin effect." Conversely, as the frequency decreases a more uniform distribution of current within the conductor is obtained. Therefore, within a given length of XL-ETFE insulated silver plated copper conductor (with 40 microinch mean plating thickness), a method could be developed such that by applying signals at various frequencies, and measuring the AC impedance at frequency of

the wire length it may be possible to determine relative extent of copper conductor degradation from varying degrees and numbers of sites of Red Plague corrosion. The levels of the variable frequency currents applied may also impact current density at corrosion sites and be used to determine effects to the characteristics of the wire from this corrosion. PHASE I: Develop a non-destructive test method to detect the presence of Red Plague. Conduct experimental and/or analytical efforts to demonstrate that Red Plague can be created consistently within a lab environment for use in the analysis of the non-destructive testing (NDT) method. It is critical that the performing company can consistently create a known amount of damage due to Red Plague within an XL-ETFE wire for verification of the non-destructive test method. PHASE II: Conduct experimental and/or analytical efforts to demonstrate proof-of-principle of proposed technology. Investigations shall consider the viability, feasibility, and cost-effectiveness of solutions to locate and quantify extent of Red Plague within XL-ETFE insulated silver plated copper conductor. Demonstrate the technology by developing a prototype in a representative environment. Demonstrate feasibility and engineering scale up of proposed technology as well as identify and address technological hurdles. Demonstrate the system’s viability and superiority under a wide variety of conditions typical of both normal and extreme operating conditions. PHASE III: Successfully demonstrate direct applicability or near-term application of technology in one or more missile defense applications. Demonstration should be in a real system or operational in a system level test-bed. This demonstration should also verify the potential for enhancement of quality, reliability, performance, and reduction of total ownership cost of the proposed subject. Commercialization pathways should be identified for both military and civilian applications. Commercialization: Equally important to military utility is the transferability of proposed technologies to Red Plague detection in aerospace, automotive, and industrial uses. The proposed technology should benefit commercial and defense systems through cost reduction as well as improved reliability and sustainment. As enabling technologies, it is anticipated that commercial and industrial transferability and applicability of such technologies will be high.